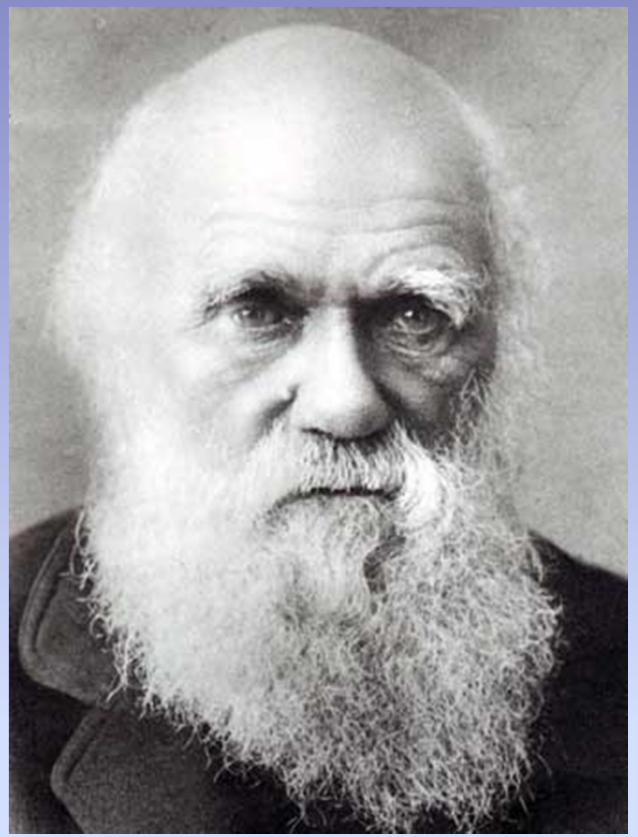
EVOLUTION

Darwin's Theory of Evolution

- ***Evolution*** =
  - Change over time
- Darwin noticed
  - Species vary globally
  - Species vary locally
  - Species vary over time



- Darwin studied ***artificial selection*** =
  - Selective breeding of organisms to promote occurrence of desirable traits in offspring

- ***Fitness*** =
  - How well an organism can survive and reproduce in an environment
- ***Adaptation*** =
  - Heritable characteristic that increases an organism's ability to survive and reproduce in an environment
- Individuals with adaptations suited to environment
  - Survive and reproduce
  - Have high fitness
- Individuals not well suited to environment
  - Die with little to no offspring
  - Have low fitness

- Adaptations can involve structures, functions, or behaviors (not acquired characteristics!)

1. To cope with climate and other abiotic factors
   - Thick fur, hibernation, migration
   - Perennial bulbs, deciduous leaves

2. To obtain food and water
   - Long neck, spider web, sharp teeth/claws
   - Root hairs, broad leaves

3. To defend against predators

- Camouflage/counter-shading, poison/warning coloration, spray, armor (quills, shells)
- Thorns, toxins

4. To attract mates OR pollinate and disperse seeds

- Sounds/calls, mating dance, exotic feathers, elaborate antlers
- Bright colors, fragrance, clinging burs, wings/parachute

- ***Natural selection*** =
  - Organisms that are most suited to their environment survive and reproduce
  - AKA: Survival of the fittest
  - Mechanism for evolution
  - Driven by competition and environmental change
  - Affects genotypes by acting on phenotypes
    - Increases frequency of beneficial alleles in a population
  - Acts only on inherited traits
    - Not acquired characteristics!

Evidence of Evolution

- Biogeography and Fossils
  - Study of where organisms lived in past and present
- Genetics and Molecular Biology
  - Universal genetic code
  - Homologous genes and proteins
- Embryology
  - Similar patterns of embryological development

- Anatomy
  - ***Homologous structures*** =
    - Similar structures in different species of common ancestry
      - Front limbs of vertebrates
    - *Supports descent with modification from common ancestor*
  - ***Analogous structures*** =
    - Share common function, not structure
      - Wing of bee and bird
    - *Not the clue to common descent*
  - ***Vestigial structures*** =
    - Inherited from ancestors but lost much or all of original function

Evolution of Populations

Genes and Variation

- ***Gene pool*** =
  - All the genes, including different alleles, that are present in a population at any one time
- ***Allele frequency*** =
  - Percentage an allele occurs in a gene pool
  - Has nothing to do with whether allele is dominant or recessive
- Evolution involves a change in the frequency of alleles in a ***population*** over time
  - Populations, not individuals, evolve

Sources of Genetic Variation

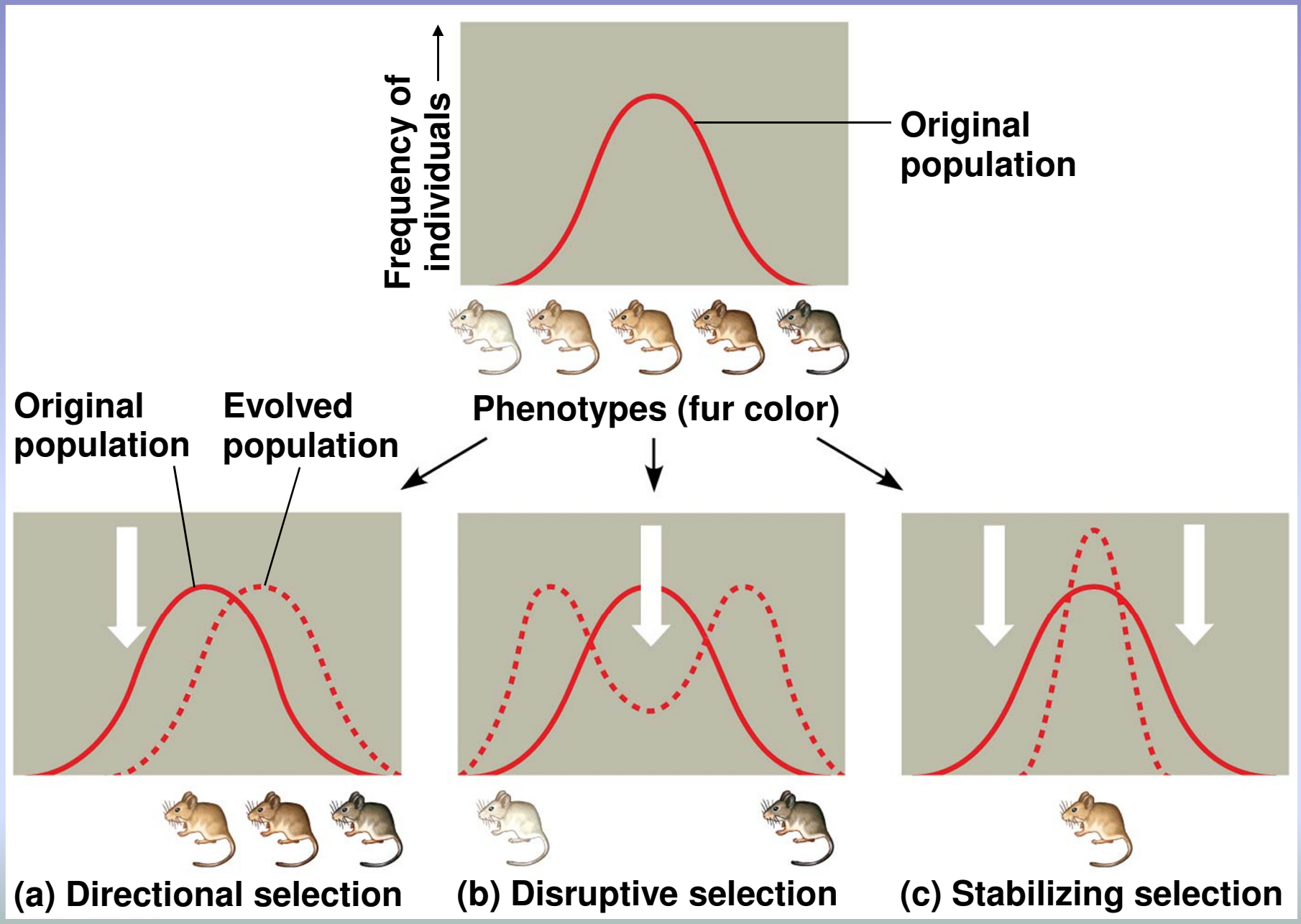
- Mutations
  - Any change in genetic material of a cell
  - Can affect individual genes or entire chromosomes
  - May or may not affect fitness
  - Matter in evolution only if passed from one generation to the next
- Genetic Recombination in Sexual Reproduction
  - Independent assortment
  - Crossing over
- Lateral Gene Transfer
  - Passing genes from one organism to another that is NOT offspring
  - Common in bacteria

3 Types of Selection

- ***Directional selection*** =
  - Favors individuals at one extreme of the phenotypic range
  - Common when a population's environment changes or migration occurs

- ***Disruptive selection*** =
  - Favors individuals at both extremes of the phenotypic range

- ***Stabilizing selection*** =
  - Favors intermediate variants and acts against extreme phenotypes
  - Ex: Birth weights of most human babies are between 6.6 and 8.8 lbs


Frequency of individuals
Original population
Phenotypes (fur color)
Original population
Evolved population
(a) Directional selection
(b) Disruptive selection
(c) Stabilizing selection

Genetic Drift

- ***Genetic drift*** =
  - Random change in allele frequency
  - ***Bottleneck effect*** =
    - Change in allele frequency following a dramatic reduction in size of population
    - Can sharply reduce genetic diversity
  - ***Founder effect*** =
    - Change in allele frequencies as a result of migration of a small subgroup of population

Evolution vs Genetic Equilibrium

- ***Genetic equilibrium*** =
  - Situation in which allele frequencies in a population remain the same

- ***Hardy-Weinberg principle*** =
  - If a population is in genetic equilibrium, then:

$$p^2 + 2pq + q^2 = 1 \quad \text{and} \quad p + q = 1$$

(frequency of AA) + (frequency of Aa) + (frequency of aa) = 100%
and (frequency of A) + (frequency of a) = 100%

  - Otherwise, evolution is taking place

Genetic equilibrium can be disturbed (thus causing evolution to occur) by:

1. Nonrandom mating
   - ***Sexual selection*** =
     - Individuals select mates based on heritable traits
2. Small population size
3. Immigration or emigration
4. Mutations
5. Natural selection

Isolating Mechanisms

- ***Speciation*** =
  - Formation of a new ***species*** =
    - Can interbreed and produce fertile offspring
- ***Reproductive isolation*** =
  - Separation of a species or population so that they no longer interbreed
  - Gene pools diverge
  - Evolve into 2 separate species

Reproductive isolation can develop through:

- ***Behavioral isolation*** =
  - 2 populations develop difference in courtship rituals or other behaviors
- ***Geographic isolation*** =
  - 2 populations are separated by geographic barriers
    - Ex: Rivers, mountains, water
- ***Temporal isolation*** =
  - 2 or more species reproduce at different times